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ABSTRACT

A paired-associate learning task, with labeled pictures as stimuli and responses, was administered to a sample of fourth and fifth grade children. Sentence and imagery mediators which linked the stimulus and response terms were either provided by the experimenter or generated by the children themselves under instructions from the experimenter. Children were tested by the recognition method after each of two study trials (study-test method). In addition, they were tested after an interval of one week to assess the long term effects of the treatments. It was found that both experimenter-imposed and subject-generated sentence and image mediators improved performance at acquisition, and that these effects persisted when subjects were tested again one week later. Moreover, children who had been instructed to generate their own mediators transferred this strategy without further instruction to a new list given during the second session a week later. To evaluate the importance of mediator recall to response recognition, children in imposed mediator conditions were asked to recall the provided mediators after they had been retested (during the second session) for recognition of all responses. The proposition that recall of the mediator was a necessary but not sufficient condition for the occurrence of the facilitative experimental effects was essentially supported. (WS)

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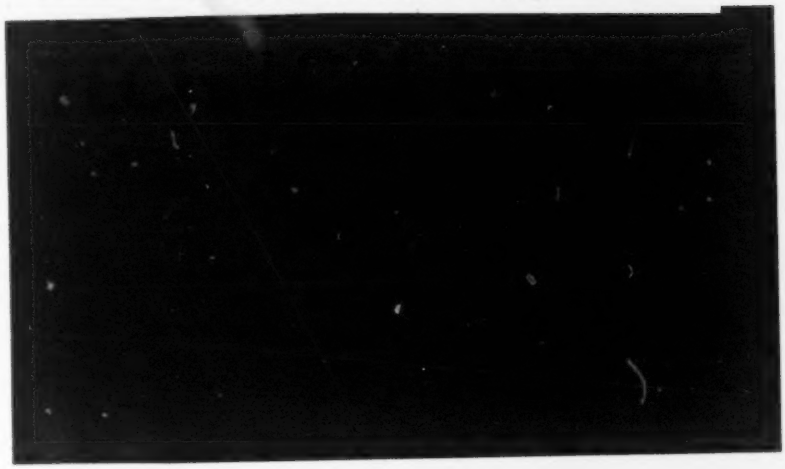

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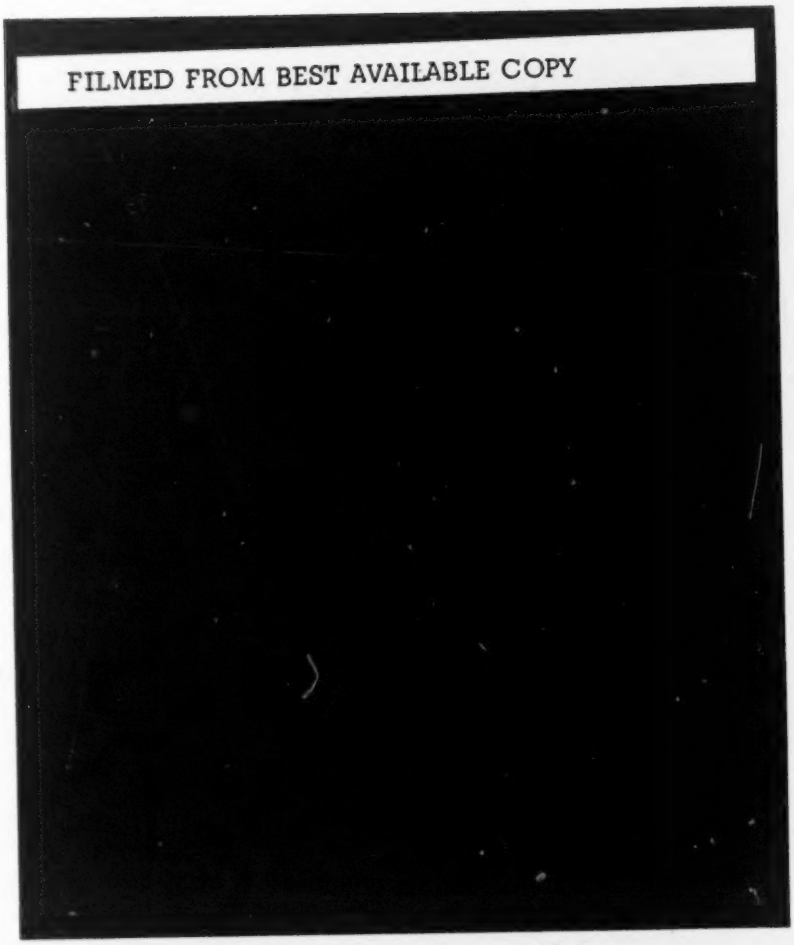

Technical Report No. 233

SHORT- AND LONG-TERM EFFECTS OF EXPERIMENTER-IMPOSED AND SUBJECT-GENERATED SENTENCE AND IMAGE MEDIATORS ON PAIRED-ASSOCIATE LEARNING IN CHILDREN

Report from the Project on Operations
and Processes of Learning

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STATEMENT OF FOCUS

Individually Guided Education (IGE) is a new comprehensive system of elementary education. The following components of the IGE system are in varying stages of development and implementation: a new organization for instruction and related administrative arrangements; a model of instructional programing for the individual student; and curriculum components in prereading, reading, mathematics, motivation, and environmental education. The development of other curriculum components, of a system for managing instruction by computer, and of instructional strategies is needed to complete the system. Continuing programmatic research is required to provide a sound knowledge base for the components under development and for improved second generation components. Finally, systematic implementation is essential so that the products will function properly in the IGE schools.

The Center plans and carries out the research, development, and implementation components of its IGE program in this sequence: (1) identify the needs and delimit the component problem area; (2) assess the possible constraints--financial resources and availability of staff; (3) formulate general plans and specific procedures for solving the problems; (4) secure and allocate human and material resources to carry out the plans; (5) provide for effective communication among personnel and efficient management of activities and resources; and (6) evaluate the effectiveness of each activity and its contribution to the total program and correct any difficulties through feedback mechanisms and appropriate management techniques.

A self-renewing system of elementary education is projected in each participating elementary school, i.e., one which is less dependent on external sources for direction and is more responsive to the needs of the children attending each particular school. In the IGE schools, Center-developed and other curriculum products compatible with the Center's instructional programing model will lead to higher morale and job satisfaction among educational personnel. Each developmental product makes its unique contribution to IGE as it is implemented in the schools. The various research components add to the knowledge of Center practitioners, developers, and theorists.

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ABSTRACT

A paired-associate learning task, with labeled pictures as stimuli and responses, was administered to a sample of fourth and fifth grade children. Sentence and imagery mediators which linked the stimulus and response terms were either provided by the experimenter or generated by the children themselves under instructions from the experimenter. Children were tested by the recognition method after each of two study trials (study-test method). In addition, they were tested after an interval of one week to assess the long term effects of the treatments. It was found that both experimenter-imposed and subject-generated sentence and image mediators improved performance at acquisition, and that these effects persisted when subjects were tested again one week later. Moreover, children who had been instructed to generate their own mediators transferred this strategy without further instruction to a new list given during the second session a week later. To evaluate the importance of mediator recall to response recognition, children in the imposed mediator conditions were asked to recall the provided mediators after they had been retested (during the second session) for recognition of all responses. The proposition that recall of the mediator was a necessary but not sufficient condition for the occurrence of the facilitative experimental effects was essentially supported.

Chapter I

INTRODUCTION

Several types of mnemonic devices have been shown to facilitate paired-associate (PA) learning. In the PA task, S is presented with pairs of words (or pictures, objects, nonsense syllables, etc.) and is later asked to recall or recognize the second (or response) member of each pair when he is shown the first (or stimulus) member of the pair. Rated concreteness or imagery-evoking capacity of the materials (Paivio, 1969), presentation of the stimulus and response terms as physically joined or interacting (Davidson and Adams, 1970), and instructions to S to form a visual image of the terms interacting (Bower, 1970a) have proved effective in the PA task. Presenting the pairs to be learned within sentences or prepositional phrases (Rohwer, 1970a) or instructing Ss to generate their own sentences (Bower, 1971) has also been found to improve performance in the PA paradigm.

Most studies concerning the effects of mnemonics on PA learning can be categorized by their position on two basic dimensions: the type of mnemonic (verbal vs imagery) and the method of implementation (imposed by E vs generated by S under instructions from E) (Levin, 1971). With few exceptions, investigators have tended to concentrate on studying one or the other of the dimensions, rather than considering both within one experimental framework.

Recently, the effects of E-imposed and S-generated verbal mnemonics

have been compared in adult populations. Bobrow and Bower (1969) and Pelton (1969) used a noun-noun PA task where Ss were either given sentences or told to make them up using the pairs to be learned. In the Bobrow and Bower experiment, E constructed the sentences which were provided, while in the Pelton study the provided sentences came from a yoked group in which Ss generated their own sentences. In an effort to make the E-provided and S-generated verbal mediators as similar as possible, Schwartz (1971) used a PA task in which a letter was the stimulus and a noun was the response, such as "A-Pie." According to word association norms, the provided mediator "apple" had a high probability of being generated by Ss in another group who were told to make up their own mediators. The results from these studies indicate that for verbal mnemonics, S-generated mediators facilitate adult performance more than mediators supplied by E.

While adult Ss have usually been used in experiments which compare S-generated and E-imposed verbal mnemonics, children are used more often as Ss when imposed verbal and image mnemonics are compared. Rohwer (1970a) used a picture PA task with E-imposed mediators where the names of the pictured objects were read aloud to S as he viewed the pictures. Conjunctions, prepositions, and verbs served as imposed verbal mediators between the spoken names of the stimulus and response terms in three different verbally mediated conditions. In the visual or image mediator conditions, the pictured objects were shown in the same relationships (via motion picture film) which were verbally described in the verbal mediator conditions. For example, for the phrase "The shoe and the chair," a shoe was pictured adjacent to a chair; for the phrase "The

shoe under the chair," the shoe was shown under the chair; and for the sentence "The shoe taps the chair," the shoe was animated to be actually tapping the top of the chair. Using kindergarten, first, third, and sixth grade Ss, Rohwer found that both imposed imagery and imposed verb and preposition mediators were facilitative at all grade levels. By the third grade, imposed imagery was more facilitative than either type of verbal mediator. A similar study by Davidson and Adams (1970) found that verbal (preposition) mediators remained more effective than imposed imagery at the second grade level. Reese (1970) suggested that this trend of increasing effectiveness of imposed image relative to imposed verbal mediators could be explained by the finding that younger children sometimes fail to "read" the interacting image. When asked to describe a picture of interacting objects, young children often merely list the objects (i.e. a shoe and a chair) rather than express the interaction (the shoe taps the chair).

The developmental trend of increased facilitation by imposed imagery relative to imposed verbal mediators is paralleled by a similar but less pronounced trend for S-generated verbal and image mnemonics. Levin (1971) compared image and sentence generation strategies on a PA task employing both picture and word pairs with second and fifth grade Ss. The previously reported sentence to imagery developmental shift occurred with picture (though not word) pairs. For the younger children, the sentence generation strategy was relatively more effective, while the imagery strategy was relatively more facilitative at the fifth grade level.

A set of experiments by Paivio and his colleagues (e.g., Paivio and Foth, 1970) has compared S-generated imagery and verbal strategies in adults.

Although the data generally reveal the effectiveness of both types of strategy (relative to control or repetition instructions), Paivio and Foth's (1970) experiment suggests the superiority of imagery, especially when the materials to be learned are concrete.

One of the few studies to include both the verbal/image and the E-imposed/S-generated distinctions is an experiment by Montague (1970). It was found that imposed imagery and sentence mediators, as well as S-generated sentence mediators were all equally superior to the S-generated image and control conditions with first grade Ss. In the above conditions, however, the effects of E-imposed and S-generated mediators are confounded because Ss in the imposed mediator conditions were also given instructions to generate linking sentences or compound pictures for the pairs to be learned. Ss in the S-generated mediator conditions were to generate images or sentences but were not provided with sentences or compound pictures. The experimental conditions thus provide comparisons between the effects produced by combining E-imposed mediators and imagery or sentence generation instructions and the effects produced by imagery or sentence generation instructions alone. In addition, such comparisons are confounded by the factor of overt verbalization, since sentence Ss were permitted to say their sentences out loud and thus receive auditory feedback, while imagery Ss made up their images covertly. One purpose of the present study is to provide direct comparisons within and across the verbal/image and E-imposed/S-generated dimensions.

Other researchers have studied the long term effects of mnemonics by varying the interval between acquisition and testing. In a test of

imagery effects on PA recall, Palermo (1970) reports that in a study by Shamp, it was found that the original superiority of noun pairs with highly concrete, high imagery stimuli decreased by 50% two days after learning.*

Olton (1969) used an imposed sentence mnemonic with noun pairs and found that the mnemonic increased the rate of acquisition but produced no effect on recall one week later when original learning had been equated for the experimental and control groups. Loadman (1971) compared the effects of S-generated and E-imposed sentence mediators on PA learning of nonsense disyllables both immediately and one week after acquistion. With sixth grade Ss, Loadman found that the control and S-generated sentence groups were equal in performance, while the E-imposed sentence group was superior to both. This effect was present at both immediate and delayed recall tests. Considering the relatively low meaningfulness of the pairs it is likely that Ss found it difficult to generate appropriate sentences.

In a study referred to earlier, Schwartz (1971) used E-imposed and S-generated word associate mediators with a letter-word PA task. She found the S-generated group to be superior to the E-imposed and control groups when adult Ss were tested immediately or 15 minutes after acquisition. Boltwood and Blick (1970) found that in a free recall task with adult Ss, both control Ss and Ss instructed to incorporate the words to be learned into a story of their own making performed perfectly when tested shortly after acquisition, but the story group performed better than the control group when both groups were tested

*Yuille (personal communication) reported that he was unable to replicate this result.

one week after original learning.

Bower and Clark (1969) found similar results when they asked Ss to learn twelve serial lists of ten nouns by the story method. Both the control and story groups performed equally well when tested for serial recall of each single list immediately after learning it. When Ss had learned all twelve lists and were asked to recall each list again, the story group recalled six to seven times as much as the control group. The authors concluded that the story mnemonic acted to reduce interlist interference and facilitate constructive recall.

Loadman used nonsense syllable pairs rather than words or pictures, Schwartz used word-associate rather than sentence mediators, Boltwood and Blick studied free recall, and Bower and Clark used a serial learning task. As a result, data from these experiments on delayed recall are not directly comparable to the acquisition data from most other PA verbal mnemonic experiments.

Rather than test for recall or originally learned material, Milgram (1967) tested for re-use of an S-generated verbal strategy on new lists one week after the original learning. Milgram found that seven year-old Ss were able to retain the strategy (records of spoken sentences were kept) without further instruction and that the strategy facilitated the learning of new lists.

Little research has been done concerning the long term effects of imagery mnemonics. Delin (1969) tested the effects of an S-generated image strategy on immediate and delayed recall in the serial learning of nouns by adult Ss. Using the anticipation method and instructions to generate an active image of each successive pair of words in as

many sensory modalities as possible, Delin found that the S-generated imagery group was superior to the control group for both original learning and relearning six weeks later.

Statement of Problem

Few experiments have been designed to allow direct comparisons both within and across the verbal/imagery and S-generated/E-imposed dimensions. In order to compare across dimensions, one must also compare across experiments which often vary with respect to age of Ss, type of materials, particular instructions, and so forth. To allow more meaningful comparisons across dimensions, both dimensions must be brought within one experimental framework. The primary purpose of the present study was to compare the effects of mediators imposed by E and mediators generated by Ss under strategy-inducing instructions from E on the short and long term recall of PA responses by fourth and fifth grade children. Both image and sentence mediators were used.

Ss in all conditions were tested for recognition of correct responses immediately after acquisition. One week later, Ss in the induced (S-generated) conditions were tested for recognition of originally learned material, as well as for retention of the induced strategy itself as demonstrated by performance on a new list where mnemonic instructions were not provided. In the conditions where specific mediators were imposed, Ss were tested on originally learned material one week after acquisition and subsequently asked to recall the specific mediators themselves. For individual Ss, correct recall of the imposed mediator was expected to be related to retrieval of the correct response. The groups were not equated on the degree of original learning, since it was intended that the results would have some potential applicability to school learning

situations, where the magnitudes of long term mnemonic effects, rather than the isolation of retention and acquisition phenomena are of greater interest.

Chapter II

METHOD

Subjects

A total of 119 fourth and fifth grade children from one elementary school served as Ss. Each S was randomly assigned to one of five conditions and tested individually. The order of conditions was randomized within blocks of five, where each block constituted a replication of all conditions in the experiment.

Materials

The materials to be learned consisted of 20 pairs of pictured objects generated by random combinations of the items. The objects within a pair were pictured as joined in physical interaction only in the imposed imagery condition. The pictures, which had been photographed onto transparencies, were line drawings of objects and animals familiar to fourth and fifth graders (e.g., a cat, a boat, a house, etc.).

Design

The effects of five methods of learning on recognition of correct response terms of picture pairs were compared. The recognition task was used so that S would not be required to produce a verbal label for the response pictures which he remembered. Memory for the PA pair was thus not confounded with ability to label the response picture.

The methods of learning consisted of the following:

1. IMPOSED IMAGERY

   The stimulus and response pictures were shown interacting with one another. This was the only condition in which the stimulus and response pictures were presented in interaction. In the remaining conditions the pictures in each pair were presented side-by-side.

2. IMPOSED SENTENCE

   Sentences which described the same interaction between the stimulus and response pictures which was visually depicted in the imposed imagery condition were read to S (via a tape recorder) as he viewed the picture pairs. Declarative sentences such as "The cat bites the apple." and "The star is under the penny." were used.

3. INDUCED (S-GENERATED) IMAGERY

   Ss were instructed to imagine the stimulus and response pictures doing something together.

4. INDUCED (S-GENERATED) SENTENCE

   Ss were told to make up a short sentence to themselves which told about the stimulus and response pictures doing something together.

5. CONTROL

   Ss were told to learn the pairs but were not given mnemonic instructions.

To provide comparable verbal labelling of the stimulus and response terms in all conditions, the tape recorded names of the pictures were

played to all Ss except those in the imposed sentence condition, where the sentence itself served to label the objects. All Ss were tested for recognition of correct responses both immediately after learning and after an interval of one week to assess the experimental effects. In order to compare retention of the imposed verbal and image mediators themselves, Ss in the imposed conditions were asked one week after original learning to recall the interaction between the stimulus and response terms which was depicted in the imposed imagery or described in the imposed sentence condition. This was done after Ss had been tested for recognition of original material. To compare the ability of Ss to retain for one week an instructionally-induced sentence strategy with the ability to retain an induced image generation strategy, Ss in the induced (S-generated) and control conditions were asked to learn a new list of picture pairs, but no mnemonic instructions were given at this time. The list was given after Ss had been tested for recognition of the original material. After learning the new list, Ss were asked if they used any strategy while learning the new picture pairs.

Procedure

A paired-associate recognition method for individual Ss was used. E presented 20 picture pairs to each S by means of a slide projector with a rear projection screen. Each pair was exposed for four seconds. In the imposed sentence condition, recorded sentences which described an interaction between the stimulus and response pictures were played to S on a tape recorder as he viewed the pairs. In all other conditions the names of the pictured objects were presented by tape recorder as

the pairs of pictures were shown.

At the beginning of each experimental session, the presentation and recognition testing procedures were explained to S. In an effort to make the instructions in all conditions equally motivating, all Ss were told that E would tell them a good way to remember which two things were together in each pair. Ss in the control and imposed image conditions were then told that whenever they saw the two things in each pair, they should look at the two things carefully and listen closely to the tape recorder for the names of the things. Ss in the imposed sentence condition were given similar instructions but were told to listen closely to the sentences on the tape recorder. Ss in the induced imagery condition were told to "Make up a picture in your mind of the two things doing something together," while Ss in the S-generated (induced) sentence condition were told to "Make up a short sentence about the two things doing something together." Ss in all conditions were then shown an example of the type of pairs which they were to learn. At this point, Ss in the S-generated image condition were asked to make up an image of the two terms, while Ss in the S-generated sentence condition were asked to construct a sentence. Ss were told to report their sentences or describe their images to E, who then gave an example of a simple declarative sentence which linked the stimulus and response terms (in the sentence condition) or displayed a picture which showed then two terms interacting (in the image condition). (During actual study trials, Ss did not report sentences or describe images to E.) Ss in all conditions were then shown just the stimulus term and were asked to point to the response picture on a small recognition

board. This procedure was repeated with a second pair, so that all Ss received two examples.

Two study-test trials were given. The order of presentation of items within the study and the test portions of the trials was randomized. During the study trials, the entire list of pairs was presented; the stimulus pictures alone were presented during the test trials. Ss were instructed to point to (recognize) the response member of each pair on a piece of cardboard which displayed all the response pictures. Each response picture was approximately two by three inches in size. Two pieces of cardboard with different random arrangements of response pictures were used and their order of appearance on the two test trials was counterbalanced. All Ss were tested on the original pairs one week later. Ss in the imposed imagery and imposed sentence conditions were then asked to recall the depicted or described interaction between the stimulus and response terms. During this recall test, both the stimulus and response terms were presented by E at an S-paced rate. In the induced sentence, induced imagery, and control conditions, Ss were asked to learn a new list of picture pairs but were not told or reminded to use a mnemonic strategy.

Chapter III

RESULTS

Analysis of Acquisition Data

Table 1A presents the mean numbers of correct responses for the experimental and control conditions when Ss were tested immediately after one study trial. A repeated measures ANOVA with one between-subjects variable (conditions) and one within-subjects variable (trials) yielded significant main effects of conditions ($F = 16.97$, $df = 4/114$, $p < .01$), and trials ($F = 371.13$, $df = 1/114$, $p < .01$), as well as a significant conditions by trials interaction ($F = 4.01$, $df = 4/114$, $p < .01$).

The total numbers of correct responses summed across trials were compared among conditions by means of the Tukey post hoc method, with the probability of a Type I error (α) set equal to .05. The control group was significantly lower in performance than each other condition. No significant pairwise differences were found among the imposed sentence, S-generated (induced) sentence, imposed image, and S-generated (induced) image conditions on the number of correct responses summed across trials.

As can be seen in Table 1A Ss gave an average of about five more correct responses on Trial 2 than on Trial 1. Scheffé post hoc comparisons within the conditions by trials interaction revealed that the control condition gained significantly more from Trial 1 to Trial 2

Table 1A

Mean Number of Correct Responses at Acquisition

Condition	Trial 1	Trial 2	Total
Control	5.70	12.87	18.57
Imposed Sentence	14.96	19.24	34.20
Imposed Imagery	12.71	17.75	30.46
S-Generated Sentence	12.12	16.96	29.08
S-Generated Imagery	13.09	17.35	30.44
Average Across Conditions	11.72	16.83	28.55

Table 1B

Variance at Trial 1 of Acquisition

Control	Imposed Sentence	Imposed Image	S-Generated Sentence	S-Generated Image
14.40	9.87	12.65	21.68	28.17

Average variance for the 2 imposed conditions = 10.76

Average variance for the 2 S-generated conditions = 24.93

(about 7.2 items) than did the four mnemonic conditions combined (about 4.6 items), which can be explained perhaps in terms of the mnemonic groups' higher Trial 1 performance.

The variance in performance at acquisition on Trial 1 for each condition is shown in Table 1B. An F max test for homogeneity of variance was conducted for the four mnemonic conditions ($F_{4,92} = 2.85$), and the hypothesis of homogeneity of variance was rejected with $\alpha = .05$. Inspection indicates that the average variance in the S-generated conditions is about twice as large as that in the imposed conditions. Figure 1 displays the distribution of scores for each condition at Trial 1 of acquisition.

Analysis of Performance on the Re-Test

Table 2 presents the mean number of correct responses and per cent of Trial 2 performance retained when Ss in all conditions were re-tested one week after acquisition. It was found that these two measures correlated .83 when within condition correlations were computed and then averaged across conditions. Separate univariate analyses yielded significant F-ratios for both the mean number of correct responses ($F = 14.06$, $df = 4/114$, $p < .01$) and the per cent retained of Trial 2 performance ($F = 7.54$, $df = 4/114$, $p < .01$). Post hoc Tukey comparisons for per cent retained and mean number correct (each with $\alpha = .05$) showed that for both of these measures--as on the acquisition data--the control group differed significantly from every other group, while no significant differences were found among the mnemonic groups.

Analysis of Performance on the New List

Table 3 presents the mean number of correct responses on new-list learning one week after learning of original material by Ss in the

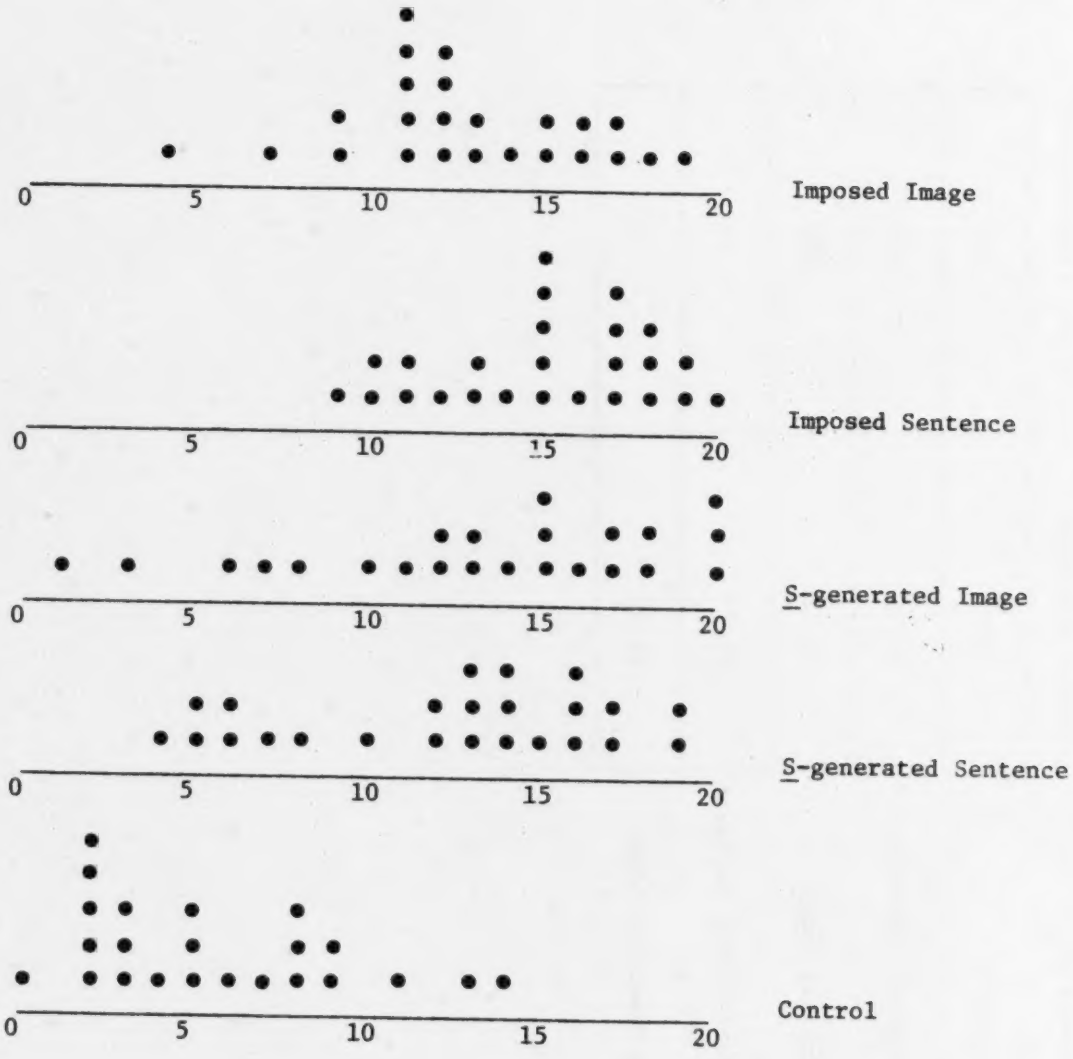

Figure 1 Distribution of Scores on Trial 1

Table 2

Mean Number of Correct Responses and Mean Percent of Trial 2 Performance When Ss Were Re-tested One Week After Acquisition

Condition	Mean Number Correct Responses	Mean Percent of Trial 2 Performance
Control	6.91	53%
Imposed Sentence	14.84	77%
Imposed Image	14.12	80%
S-Generated Sentence	13.17	77%
S-Generated Image	13.13	74%

Table 3

Mean Number of Correct Responses on the New List,

According to Both Assigned and Reported Strategies*

	Assigned Strategy	Reported Strategy
Control (No Strategy or Idiosyncratic Strategy)	9.17	9.37
S-Generated Sentences	13.62	14.60
S-Generated Imagery	14.17	15.07

*E failed to ask one S if he used a strategy, so this S's score was omitted from the data in Table 3. This resulted in an artifactual increase in the means of the REPORTED STRATEGY cells.

S-generated imagery, S-generated sentence, and control conditions. Data in the left column of the table are categorized on the basis of the strategy group to which Ss were initially assigned (i.e., control, S-generated sentence, S-generated imagery). Data in the right column are categorized on the basis of Ss' use of one of the following strategies reported immediately after new-list learning: 1) no strategy or idiosyncratic strategy, 2) generated sentences, or 3) generated images. Using the Dunn multiple comparison procedure, (rather than the previously used Tukey method, since sample sizes differed considerably in Column 2 of Table 3) one set of the three possible pairwise comparisons was made among conditions defined by assigned strategy, and another set of three comparisons was made among the conditions defined by reported strategy (with $\alpha = .016$ for each comparison). In both sets of comparisons, the control group gave significantly fewer correct responses than either of the S-generated mnemonic groups, but the S-generated sentence and imagery groups did not differ in performance.

A chi-square test of homogeneity was performed on the frequencies in Table 4 to determine if Ss' reported re-use of a strategy on the new list was related to the strategy which he had been assigned a week earlier. Reported strategy was not independent of assigned strategy ($\chi^2 = 16.81$, $df = 2$). Scheffé-like post hoc comparisons using $\alpha = .05$ (Marascuilo, 1966) indicated that Ss continued to use the strategies to which they had been previously assigned: a significantly higher incidence of sentence strategy use was reported by the sentence group (67%) than by the imagery group (21%). The reverse was true for reports of imagery strategy, where a higher proportion of imagery group

Table 4

Frequencies of Types of Strategies Reported by Ss in the S-Generated Sentence and Imagery Conditions After New-List Learning

		Assigned Strategy: Sentence	Assigned Strategy: Imagery
Reported Strategy	None	7	4
	Sentence	16	5
	Imagery	1	13

Ss reported using such a strategy (54%) than did sentence group Ss (4%). The sentence and image groups did not differ significantly in the proportion of Ss who reported having used no strategy.

Analysis of Mediator Recall

Table 5 presents a set of averaged conditional probabilities for response recognition and mediator recall for the two imposed mediator groups one week after original learning. Ss were first tested on the entire list for recognition of correct responses. Afterward, Ss were shown the stimulus and response terms in each pair and were asked to recall the imposed sentence or image mediator which linked the two pictured objects. In the imposed sentence conditions, recall of the original mediating verb or a synonym was considered a correct response. For example, if the imposed sentence was "The hand holds the bottle," the responses "The hand grabs the bottle," and "The hand hangs onto the bottle" were also accepted. In the imposed image conditions, an accurate description of the physical interaction between the stimulus and response pictures was accepted as correct, i.e., "The hand is wrapped around the bottle."

Descriptively, the imposed image and sentence conditions appear to differ mainly on the probability of getting the correct response given that the mediator was not correct $\left(P(R|\overline{M})\right)$. These probabilities were 55% for the imagery group and 70% for the sentence group. The other difference of interest results from comparing the probability (averaged across conditions) of getting the response correct given that the mediator was correct $\left(P(R|M) = 75.5\%\right)$ and the probability of getting the mediator correct given that the response was correct $\left(P(M|R) = 86\%\right)$.

Table 5

Conditional Probabilities of Response

Recognition and Mediator Recall

	Response Correct Given Mediator Was:		Mediator Correct Given Response Was:	
	Correct $(R\|M)$	Incorrect $(R\|\bar{M})$	Correct $(M\|R)$	Incorrect $(M\|\bar{R})$
Imposed Sentence	76%	70%	85%	74%
Imposed Imagery	75%	55%	87%	72%

Table 6 presents condensed information derived from the data summarized in Table 5. For each S in the two imposed mediator conditions, the pairs of conditional probabilities shown in parts A, B, and C of Table 7 were computed, and it was determined which member of each pair was greater. The cell entries are the number of Ss for whom the indicated relationships held between the members of a pair of conditional probabilities. Chi-square tests of homogeneity ($\alpha = .05$) indicated that in each of the three tables, no significant relationship was obtained between experimental condition and the indicated relationships within pairs of conditional probabilities.

Three predictions had been made concerning the relationships between conditional probabilities of mediator recall and response recognition regardless of condition. First, it was expected that the probability of recognizing the correct response would be greater for those items for which the mediator was recalled than for items where the mediator was not recalled [$P(R|M) > P(R|\overline{M})$]. Table 6A displays the data relevant to this prediction. Secondly, it was predicted that the probability of correctly recalling the mediator would be greater for those items for which the response was correctly recognized than for items where the response was not recognized [$P(M|R) > P(M|\overline{R})$]. The relevant data are shown in Table 6B. These predictions follow from the assumption that mediator recall and response recognition are interrelated. A third prediction was based on the assumption that the recall of an imposed mediator is a necessary but not sufficient condition for the facilitative effects of imposed mediators on response recognition. It was expected that the probability of recalling the mediator for items for which the correct response was recognized would

be greater than the probability of recognizing the correct response for items where the mediator was recalled [$P(M|R) > P(R|M)$]. Mediator recall was thus expected to accompany and facilitate, but not insure, response recognition. Table 6C displays the relevant data. Since the marginal frequencies in each of the three tables indicate the proportion of Ss for whom the above relationships held, comparisons were made between the marginal frequencies for each table. Three one tailed single-sample Z tests of proportions were performed ($\alpha = .05$, $Z = 1.7$, 1.8, and 3.5 for tables A, B, and C respectively), and it was found that in each case the proportion of Ss exhibiting the predicted relationship significantly exceeded the proportion of Ss who did not exhibit the relationship. Interpretations of these findings will be made in the following chapter.

Table 6

Conditional Probabilities Relating Recall of an Imposed Mediator(M) and Recognition of the Correct Response(R)

(Cell entries are the number of Ss for whom the indicated relationship was obtained.)

A. Was $P(R|M) > P(R|\overline{M})$?

	Imposed Image	Imposed Sentence	
YES	15	12	27
NO	8	8	16
			43

B. Was $P(M|R) > P(M|\overline{R})$?

	Imposed Image	Imposed Sentence	
YES	15	13	28
NO	8	8	16
			44

C. Was $P(R|M) > P(M|R)$?

	Imposed Image	Imposed Sentence	
YES	3	7	10
NO	17	16	33
			43

Chapter IV

DISCUSSION

The results indicate that Ss in the mnemonic conditions performed significantly better during acquisition than control Ss, but that there were no significant differences in performance among the mnemonic conditions. The conditions X trials interaction may likely have resulted from the length of the list used, i.e. 20 items. On Trial 1, Ss in the mnemonic conditions gave an average of 65% correct responses, while Ss in the control condition gave only 30% correct responses. On Trial 2, the mnemonic conditions had an average of 89% correct responses, while the control condition performed only at the 64% level. If the list were longer, the conditions X trials interaction would be expected to vanish, since the mnemonic conditions would then have ample "room for improvement," i.e. a sizeable proportion of responses yet to be learned.

The acquisition data are in the same direction of those that Davidson and Adams (1970) obtained with second grade Ss, where imposed verbal mediators were slightly superior to imposed imaginal ones. The present results for fourth and fifth grade Ss do not indicate the developmental trend of increasing effectiveness of imaginal relative to verbal mediators that Rohwer (1970) has reported with imposed mnemonics. Rohwer, however, used motion pictures as being representative of imposed imagery rather than juxtaposed still picture interactions used by Davidson and Adams (1970) and in the present study.

In addition to improving performance, imposed mediators reduced performance differences among Ss. At acquisition, the average variance for the two imposed conditions on Trial 1 (10.76) was less than half as large as the average variance of the S-generated conditions (24.93), while the control group had a variance of 14.40. These figures suggest that provided mediators reduce the effects of individual differences on learning relative to those conditions where Ss are given no mnemonic aids (control condition) or when they are asked to make up their own sentence or image mediators.

Ss differed little on the ability to make use of a provided mediator, but varied widely with respect to the ability to generate an effective mediator themselves. Whether the highly variable performance of the S-generated groups is due to variation in the number or effectiveness of the mediators produced is not clear. Since the rate of presentation in the present study (4 sec.) was rather rapid, it may be that some Ss in the S-generated conditions found it difficult to make up an image or a sentence in the time allowed, and that a good deal of variation occurred in the number of mediators generated. If this were the case, the variability in the performance of S-generated conditions would be expected to decrease if the duration of presentation of each pair was increased. This variability would also be expected to decrease if more training in image and sentence generation were given, or if older children were tested.

When Ss were tested on originally learned material a week later, the results paralleled those at acquisition. It is worth mentioning that many Ss showed surprise at being re-tested on the same pictures, since they had originally been told that they would do something different when they returned. Since Ss did not anticipate being re-tested,

it is probable that they did not rehearse the material during the week between experimental sessions.

All mnemonic conditions were superior to the control condition, but the mnemonic groups did not differ among themselves, whether the percent of Trial 2 learning or the absolute number of correct responses was considered. It is interesting to note that a direct or positive relationship between the amount learned and the amount lost is not found here. In fact, quite the opposite occurred, since Ss who learned more initially (those in the mnemonic conditions) also retained a higher proportion of these items (see Table 2). In interpreting this, it should be remembered that the groups were not equated on degree of original learning, since it was intended that the results would have some applicability to school learning situations, where the magnitudes of long-term mnemonic effects, rather than the isolation of acquisition and retention phenomena, are of greater interest. As a result, it is not possible to separate retention and forgetting effects from effects due to the rate or degree of original learning. Ss in the mnemonic conditions either learned each response better at acquisition and/or each response was more resistant to forgetting than in the control conditions.

When Ss in the control and S-generated conditions learned a new list one week after original learning, many (67% for the sentence group, 54% for the imagery group) reported using the strategy which they had been asked to use a week earlier. Ss had not been reminded the week before (as they were in the Milgram [1967] study) to keep the strategy in mind for future use, nor were they reminded when they

learned the new list. E queried Ss on their use of a strategy in an offhand, non-demanding, and general way, i.e. "When you were learning which two things went together in each of these new pictures, did you do anything special to help you remember which two things went together?" It is possible, however, that the re-test on original material, which preceded the learning of the new list, evoked the image or sentence strategy which had been used to learn the original list. This newly evoked strategy might then have been transferred to the learning of the new list. To examine this possibility, one could compare two groups on reported transfer of strategy to a new list: One group which had been previously re-tested on the original list, and one group which had not. If the re-test served to evoke the strategy, the group which had been re-tested on the original list should report greater transfer of the strategy to the new list than the group which had not been re-tested.

Certainly, Ss may have been "prompted" to re-use a mnemonic strategy by the fact that the same task, the same E, and the same room were used for both experimental sessions. Since the effectiveness of a particular learning strategy may be greatest with a certain range of tasks, task similarity would be the most educationally relevant of the three prompts. Its effects on re-use of a mnemonic strategy could be separated from the effects of the other prompts by varying either the similarity of Es, rooms, or tasks between original and new list learning while holding the remaining two factors constant.

Five Ss in the induced imagery condition reported using a sentence strategy on the new list, while only one S in the induced imagery condition reported using a sentence strategy. While this represents a

small number of subjects on which to base any firm conclusions, it may be that some Ss covertly verbalize as they generate an image, and that this covert verbalization replaces the original imagery strategy. Going spontaneously in the opposite direction, from generated sentences to generated images, appears to be less likely, since only one S reported making this switch.

The results for new list learning were similar to those at acquisition and at the delayed re-test on original learning. The S-generated mnemonic conditions were equal to one another and superior to the control condition, whether a condition was defined on the basis of assigned or reported strategy (Table 3). These results indicate that fourth and fifth grade children can effectively recall and re-use a mnemonic strategy that had been previously induced by instructions.

The data concerning recall of the mediating interaction itself suggest that recalling the mediator is more essential to recognizing the correct response term in the imposed imagery than in the imposed sentence conditions (Table 5). Ss in the imposed sentence condition who failed to recall the mediator correctly managed to recognize the correct response anyway 70% of the time, while this figure is 55% for Ss in the imposed image condition. It is intuitively plausible that the stimulus, the mediating interaction, and the response form more of an integrated whole in the imposed imagery than in the imposed sentence condition. If this were the case, one would expect that recall of the mediating interaction would be more crucial to recognition of the correct response in the imposed imagery condition,

as the data suggest. In addition, one would expect that if recognition were tested by supplying the response term rather than the stimulus term, imagery Ss would show less of a decrement in performance than sentence Ss.

For the imposed image and sentence conditions combined, the probability of correctly recognizing the response given that the mediator was correctly recalled ($R|M = 75.5\%$) was less than the probability of recalling the mediator given that the response was correct ($M|R = 86\%$). That is, if S had "made his way" to the correct response, it is probable (86%) that he could recall the mediator. If S recalled the mediator, it is slightly less probable (75.5%) that he would then reach the correct response. Statistical support for this proposition comes from the finding that the proportion of Ss for whom $P(M|R) > P(R|M)$ is significantly greater ($\alpha = .05$) than the proportion of Ss for whom $P(M|R) < P(R|M)$. It was also found that the proportion of Ss for whom $P(R|M) > P(R|\overline{M})$ was significantly greater ($\alpha = .05$) than the proportion of Ss for whom the reverse was true. That is, the more frequently observed relationship was that for a given S, the probability of a correct response given that the mediator was correctly recalled was greater than the probability of a correct response given that the mediator was not correctly recalled. In addition, the proportion of Ss for whom $P(M|R) > P(M|\overline{R})$ was significantly greater ($\alpha = .05$) than the proportion of Ss for whom the opposite relationship held. In other words, the more common relationship was that for a given S, the probability of recalling the mediator given that the response was correct exceeded the probability of recalling the mediator given that the response was not correct. That is, if an S had "made his way" to the correct response, he was more

likely to be able to recall the mediator than if he had not given the correct response. These data, considered in conjunction with the facilitative effects of E imposed mediators, suggest that recall of a provided mediator is a necessary but not sufficient condition for the occurrence of the facilitative effects.*

In summary, the present experiment found two basically different types of mnemonics to be effective. Learning increased when a sentence or special picture was provided which linked the two pictured objects by describing or depicting an interaction between them. When fourth and fifth grade Ss were asked to make up their own sentences or to imagine pictures to link the two objects, learning also improved. These results suggest that learning improves when either the materials are well organized for students or when students are instructed to organize the material themselves.

Other studies (Rohwer, 1970b) have shown that proficient learners often generate their own organizational aids when they try to understand or remember information. On the other hand, poor learners often fail to generate effective strategies for organization on their own. However, when given appropriate instruction in organization, poor learners frequently perform at a level comparable to that of good learners, thus suggesting that such skills may be taught. The present study supports the proposition that the organizational skills of image and sentence generation can be taught and that they facilitate performance at acquisition, on a delayed re-test, and in a transfer situation.

*One cannot claim that recall of the mediator is necessary for recognition of the correct response, since control Ss, who were not given mediators, did correctly recognize some responses.

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APPENDIX A

Individual Scores by Conditions

IMPOSED IMAGE

Acquisition		Re-Test	Mediator Recall
T_1	T_2	T_3	
16	20	19	19
17	20	13	18
13	14	13	15
12	18	12	15
11	19	18	16
12	18	15	17
11	18	12	12
17	20	16	18
11	17	10	16
19	18	17	18
11	18	17	18
14	19	20	20
4	16	8	14
18	20	18	18
9	15	16	16
11	19	12	14
15	20	16	19
15	18	11	13
16	20	17	19
12	19	15	18
9	18	9	16
13	15	17	16
12	17	11	15
7	10	7	13

IMPOSED SENTENCE

Acquisition		Re-Test	Mediator Recall
T_1	T_2	T_3	
15	18	12	18
12	19	19	14
17	19	16	16
10	20	8	10
13	19	18	19
11	18	10	15
19	19	16	19
13	20	9	17
15	20	17	15
15	20	20	18
14	20	14	16
10	19	18	10
20	20	17	16
15	19	14	17
17	20	16	17
18	20	15	16
19	20	16	17
16	19	11	17
18	20	12	18
17	20	20	19
9	16	11	19
11	18	18	15
18	19	14	18
17	20	19	19
15	19	11	19

S--GENERATED SENTENCE

Acquisition		Re-Test	Mediator Recall
T_1	T_2	T_3	
13	16	16	8
19	20	17	17
17	20	20	15
12	19	11	13
17	20	14	10
6	10	9	2
7	10	6	18
16	18	14	17
13	18	15	14
14	20	20	15
16	20	17	19
13	20	18	18
14	17	13	2
4	9	7	9
5	7	4	15
16	19	15	15
14	17	14	13
8	19	10	12
15	20	17	18
10	18	11	15
19	20	14	14
12	19	16	16
6	14	10	15
5	17	8	17

S-GENERATED IMAGE

Acquisition		Re-Test	New List
T_1	T_2	T_3	
13	15	12	14
1	11	9	7
15	20	9	16
11	19	11	19
17	19	15	17
16	20	18	19
20	20	20	20
10	16	7	12
13	19	19	19
12	18	10	5
18	20	15	19
14	18	13	17
6	15	16	8
7	12	2	13
8	18	7	7
20	20	19	19
18	20	18	19
12	16	12	13
20	20	18	14
17	19	18	17
15	19	16	20
15	18	15	9
3	7	3	3

CONTROL

Acquisition T_1	T_2	Re-Test T_3	New List
11	19	12	11
3	9	4	2
5	15	6	12
14	20	12	16
4	16	6	7
2	5	4	2
3	6	2	10
6	10	8	13
9	13	5	10
2	7	2	5
2	9	5	8
8	18	12	10
7	17	11	17
0	11	6	3
2	8	2	2
13	18	9	13
5	15	6	9
8	16	5	14
5	16	6	13
3	6	5	5
9	13	9	11
8	18	15	7
2	11	7	11

APPENDIX B

Original List Presented on Acquisition Trials 1 and 2		Imposed Sentence Mediator Used in Imposed Sentence Condition*
pen	horse	The pen draws the horse.
spider	shirt	The spider crawls up the shirt.
belt	wheel	The belt hits the wheel.
star	penny	The star is under the penny.
boat	frog	The boat carries the frog.
monkey	boy	The monkey likes the boy.**
lamp	key	The lamp shines on the key.
hard	bottle	The hand holds the bottle.
bat	window	The bat sticks through the window.
house	chicken	The house falls on the chicken.
purse	mailbox	The purse is inside the mailbox.
cat	apple	The cat bites the apple.
gun	spoon	The gun shoots the spoon.
tree	bus	The tree grows through the bus.
bicycle	knee	The bicycle bumps the knee.
tie	moon	The tie hangs from the moon.
piano	tracks	The piano is on the tracks.
tire	mouse	The tire chases the mouse.
hat	chair	The hat leans against the chair.
owl	jar	The owl is in the jar.

*Line drawings of the interactions described in these sentences served as the corresponding imposed image mediator in the imposed image condition.

**The monkey was shown with his paw around the boy's shoulder.

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